AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims

1. (Currently amended) A method ~~to synthesize a robust controller to~~ for controlling a ~~process of the type which may be modeled imperfectly~~ plant, said method comprising:

a. providing ~~an~~ generalized plant model as in a ~~prior art~~ D-K iteration method ~~for synthesizing robust controllers~~, said generalized plant model comprising a nominal plant model, one or ~~a plurality of selected~~ more perturbation weightings, one or ~~a plurality of selected~~ more performance weightings, input ports, and output ports, said input ports configured for perturbation input, exogenous input, and control input, ~~and~~ said output ports configured for perturbation output, exogenous output, and control output, said control input and said control output corresponding to a controller to be designed;

b. providing a convex closed-loop map by applying a parameterization method on said generalized plant model, said convex closed-loop map being convex in terms of a free controller design parameter, ~~;~~ said convex closed-loop map having a plurality of input channels corresponding to ~~the~~ said exogenous input and ~~the~~ said perturbation output of said generalized plant model, said convex closed-loop map having a plurality of output channels corresponding to ~~the~~ said exogenous output and ~~the~~ said perturbation input of said generalized plant model, said free controller design parameter being a stable system;

c. ~~providing a means for~~ optimizing a robust scaling for a robustness measure relating to said convex closed-loop map, while holding said free controller design parameter fixed, said robust scaling corresponding to ~~the robust~~ a scaling of said ~~prior art~~ D-K iteration method, said robustness measure corresponding to a ~~robustness~~ measure of said ~~prior art~~ D-K iteration method;

d. computing said free controller design parameter by formulating a controller optimization problem while holding said robust scaling fixed, said controller optimization problem relating to said robustness measure and ~~some~~ one or more other measures of said convex closed-loop map; and

e. iterating step c and step d until a stopping criterion is satisfied.

2. (Currently amended) The method ~~in~~ of claim 1 wherein ~~the~~ a frequency response of said robust scaling is optimized on a set of selected frequencies, and said ~~convex~~ controller optimization problem formulates said robustness measure on a number of said set of selected frequencies~~,~~ based on a selected frequency gridding.

3. (Currently amended) The method ~~in~~ of claim 1 wherein said one or more perturbation weightings ~~is~~ are provided directly from a nonparametric estimate of ~~the~~ at least a modeling uncertainty of said nominal plant model on a finite number of selected frequencies.

4. (Currently amended) The method ~~in~~ of claim 1 wherein said ~~convex~~ controller optimization problem formulates said robustness measure on a set of selected frequencies based on frequency gridding, ~~the~~ decision variables of said controller optimization problem are ~~the~~ at least a frequency response of said free controller design parameter on said set of selected frequencies, and an ~~the~~ inverse discrete Fourier transform of said frequency response is constrained to be periodically stable.

5. (Currently amended) The method ~~in~~ of claim 1 wherein said ~~convex~~ controller optimization problem formulates said robustness measure on a set of selected frequencies based on frequency gridding, ~~the~~ and decision variables of said controller optimization problem are ~~the~~ coefficients of said free controller design parameter on said set of selected frequencies.

6. (Currently amended) The method ~~in~~ of claim 1 wherein said controller optimization problem ~~are~~ is changed during said iteration in step e.

7. (Currently amended) The method ~~in~~ of claim 1 wherein said parameterization method relates to Youla-parameterization.

8. (Currently amended) A method ~~to synthesize a robust controller to~~ for controlling a ~~process of the type which may be modeled imperfectly~~ plant, said method comprising:

a. providing ~~an~~ generalized plant model as in a ~~prior-art~~ D-K iteration method ~~for synthesizing robust controllers~~, said generalized plant model comprising a nominal plant model, one or ~~a plurality of selected~~ more perturbation weightings, one or ~~a plurality of selected~~ more performance weightings, input ports, and output ports, said input ports configured for perturbation input, exogenous input, and control input, ~~and~~ said output ports configured for perturbation output, exogenous output, and control output, said control input and said control output corresponding to a controller to be designed;

b. providing a convex closed-loop map by applying a parameterization method on said generalized plant model, said convex closed-loop map being convex in terms of ~~afreecontroller~~ a free controller design parameter, ~~;~~ said convex closed-loop map having a plurality of input channels corresponding to ~~the~~ said exogenous input and ~~the~~ said perturbation output of said generalized plant model, said convex closed-loop map having a plurality of output channels corresponding to ~~the~~ said exogenous output and ~~the~~ said perturbation input of said generalized plant model, said free controller design parameter being a stable system;

c. ~~providing a means for~~ finding a robust scaling such that a robustness measure achieves a robustness level, said robust scaling corresponding to ~~the robust~~ a scaling of said ~~prior-art~~ D-K iteration method, said robustness measure corresponding to a ~~robustness~~ measure of said ~~prior-art~~ D-K iteration method; and

d. computing said free controller design parameter by formulating a controller optimization problem while holding said robust scaling fixed, said control optimization problem relating to said robustness measure, said robustness level, and ~~some~~ one or more other measures of said convex closed-loop map. ~~;~~

9. (Currently amended) The method ~~in~~ of claim 8 wherein ~~the~~ a frequency response of said robust scaling is optimized on a set of selected frequencies, and said ~~convex~~ controller optimization problem formulates said robustness measure on a number of said set of selected frequencies, based on a selected frequency gridding.

10. (Currently amended) The method ~~in~~ of claim 8 wherein at least one of said one or more perturbation weightings is provide directly from a nonparametric estimate of ~~the~~ at least a modeling uncertainty of said nominal plant model on a finite number of selected frequencies.

11. (Currently amended) The method ~~in~~ of claim 8 wherein said ~~convex~~ controller optimization problem formulates said robustness measure on a set of selected frequencies based on frequency gridding, ~~the~~ decision variables of said controller optimization problem are ~~the~~ at least a frequency response of said free controller design parameter on said set of selected frequencies, ~~the~~ and an inverse discrete Fourier transform of said frequency response is constrained to be periodically stable.

12. (Currently amended) The method ~~in~~ of claim 8 wherein said ~~convex~~ controller optimization problem formulates said robustness measure on a set of selected frequencies based on frequency gridding, ~~the~~ and decision variables of said controller optimization problem are ~~the~~ coefficients of said free controller design parameter on said set of selected frequencies.

13. (Currently amended) The method ~~in~~ of claim 8 wherein said parameterization method relates to Youla-parameterization.

14. (Currently amended) The method ~~in~~ of claim 8 wherein said ~~means for~~ finding said robust scaling involves ~~with~~ a direct search based on gridding of ~~the~~ a parameter space of said robust scaling.

15. (Currently amended) The method ~~in~~ of claim 8 wherein ~~step c~~ said ~~means for~~ finding said robust scaling comprises:

~~a.~~x. ~~providing a means for~~ optimizing a robust scaling variable for said robustness measure relating to said convex closed-loop map, while holding said free controller design parameter fixed;

~~b.~~y. computing said free controller design parameter by formulating a controller optimization problem while holding said robust scaling variable fixed, said controller optimization problem relating to said robustness measure;

~~c.~~z. iterating step ~~a~~ x and step ~~b~~ y until a stopping criterion is satisfied.

16. (Currently amended) The method ~~in~~ of claim 8 wherein ~~step d~~ at least one input-output channel relating to said ~~some~~ one or more other measures of said convex closed-loop map is included in said robustness measure.~~,~~

17. (Currently amended) The method ~~in~~ of claim 8 wherein ~~step d all the~~ input-output channels relating to said ~~some~~ one or more other measures of said convex closed-loop map~~, and all the~~ are different from input-output channels of said robustness measure~~, are different~~.

18. (Currently amended) A method ~~to synthesize a robust controller to~~ for controlling a ~~process of the type which may be modeled imperfectly~~ plant, said method comprising:

a. providing ~~an~~ generalized plant model as in a ~~prior art~~ D-K iteration method for synthesizing ~~robust~~ controllers, said generalized plant model comprising a nominal plant model, one or ~~a plurality of selected~~ more perturbation weightings, one or ~~a plurality of selected~~ more performance weightings, input ports, and output ports, said input ports configured for perturbation input, exogenous input, and control input, ~~and~~ said output ports configured for perturbation output, exogenous output, and control output, said control input and said control output corresponding to a controller to be designed, at least one of said one or more perturbation weightings is provide directly from a nonparametric estimate of the modeling uncertainty of said nominal plant model on a finite number of selected frequencies;

b. providing a convex closed-loop map by applying a parameterization method on said generalized plant model, said convex closed-loop map being convex in terms of a free controller design parameter~~,~~ said convex closed-loop map having a plurality of input channels corresponding to ~~the~~ said exogenous input and ~~the~~ said perturbation output of said generalized plant model, said convex closed-loop map having a plurality of output channels corresponding to ~~the~~ said exogenous output and ~~the~~ said perturbation input of said generalized plant model, said free controller design parameter being a stable system;

c. ~~providing a means for~~ optimizing a robust scaling for a robustness measure relating to said convex closed-loop map, while holding said free controller design parameter fixed, said robust scaling corresponding to ~~the robust~~ a scaling of said ~~prior art~~ D-K iteration method, said robustness measure corresponding to a ~~robustness~~ measure of said ~~prior art~~ D-K iteration method;

d. computing said free controller design parameter by formulating a controller optimization problem while holding said robust scaling fixed, said controller optimization problem relating to said robustness measure; and

e. iterating step c and step d until a stopping criterion is satisfied.

19. (Currently amended) A method ~~to synthesize a robust controller to~~ for controlling a process ~~of the type which may be modeled imperfectly~~, said method comprising:

a. providing ~~an~~ generalized plant model as in ~~a prior art~~ a D-K iteration method for synthesizing ~~robust~~ controllers, said generalized plant model comprising a nominal plant model, one or ~~a plurality of selected~~ more perturbation weightings, one or ~~a plurality of selected~~ more performance weightings, input ports, and output ports, said input ports configured for perturbation input, exogenous input, and control input, ~~and~~ said output ports configured for perturbation output, exogenous output, and control output, said control input and said control output corresponding to a controller to be designed;

b. providing a convex closed-loop map by applying a parameterization method on said generalized plant model, said convex closed-loop map being convex in terms of a free controller design parameter, ~~:~~ said convex closed-loop map having a plurality of input channels corresponding to ~~the~~ said exogenous input and ~~the~~ said perturbation output of said generalized plant model, said convex closed-loop map having a plurality of output channels corresponding to ~~the~~ said exogenous output and ~~the~~ said perturbation input of said generalized plant model, said free controller design parameter being a stable system;

c. ~~providing a means for~~ optimizing a robust scaling for a robustness measure relating to said convex closed-loop map, while holding said free controller design parameter fixed, said robust scaling corresponding to ~~the robust~~ a scaling of said ~~prior art~~ D-K iteration method, said robustness measure corresponding to a ~~robustness~~ measure of said ~~prior art~~ D-K iteration method;

d. computing said free controller design parameter by formulating a controller optimization problem while holding said robust scaling fixed, said controller optimization problem relating to said robustness measure, said ~~convex~~ controller optimization problem formulates said robustness measure on a set of selected frequencies based on frequency gridding, ~~the~~ decision variables of said controller optimization problem are ~~the~~ at least a frequency response of said free controller design parameter on said set of selected

frequencies, ~~the~~ at least an inverse discrete Fourier transform of said frequency response is constrained to be periodically stable; and

e. iterating step c and step d until a stopping criterion is satisfied.